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(54) An actuator for a flame-safeguarded gas burner with regulation solenoid valve.

(57) An actuator for a flame-safeguarded gas burner with a regulator valve comprising a first safety valve (5) driven by a magnetic assembly (10,11) with manual setting (17), a second regulator valve (7) in cascade with said first valve (5), a tapping conduit (15) intermediate to said first (5) and second (7) valves for feeding a pilot flame nozzle (16), a pilot flame detecting thermocouple (12) for powering said magnetic assembly (11) and holding said first safety valve (5) open in the presence of the pilot flame and a thermopile (21) for powering an electromagnetic device (20) driving said second valve (7).

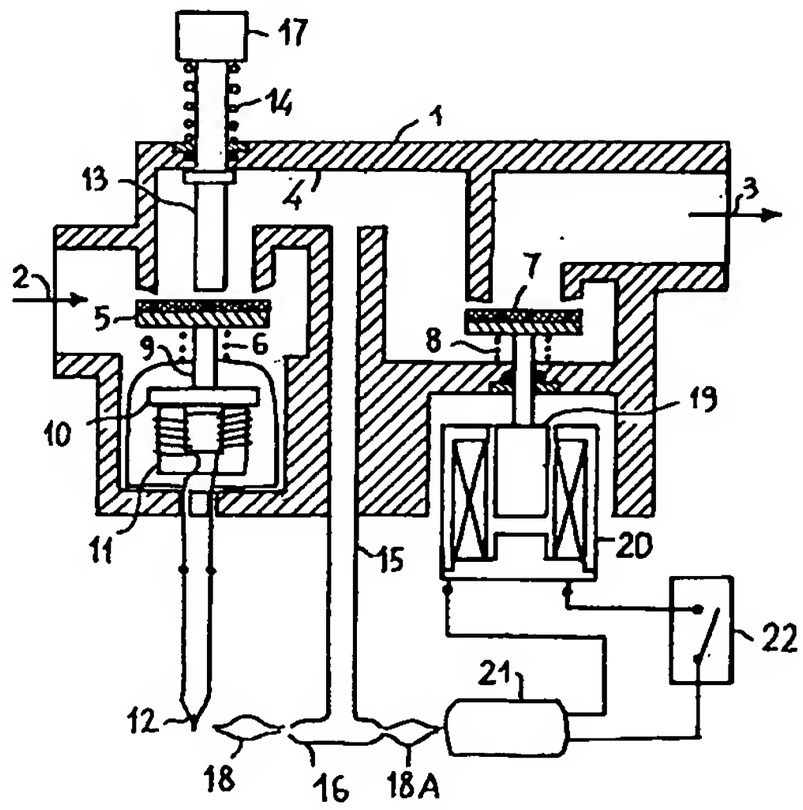

FIG.1

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The present invention relates to a flame-safeguarded thermostatically regulated gas burner actuator.

It is known that increasingly stricter safety requirements are being enforced on gas-burning heaters, such as household ovens, boilers, and the like, especially in connection with the use of inflammable (air/methane) mixtures having a high available heat value and high rate of flame propagation, and hence a high potential for blasting.

Thus, the actuators are provided with protections, and comprise two cascaded shutoff valves, a first safety valve being preferably controlled, but not limited thereto, by a pilot flame detector, which flame is to be constantly lit, a second regulator valve being controlled by a thermostatic device which generally applies a regulation of the on/off type by opening and closing electric contacts which allow an electromagnet driver for the regulator valve to be energized intermittently.

The "off" response of the safety valve, in the event of the pilot flame being extinguished, should be specially fast.

A further requirement of the actuators is a capability for self-supported operation, whereby they can operate without requiring an external power source.

Known are twin shutoff valve actuators wherein a first safety valve is driven by an electromagnetic assembly powered from a thermocouple heated by the pilot flame.

The assembly is set manually, whereupon the safety valve is opened and gas is admitted to the nozzle of the pilot flame, which may be lighted using piezoelectric spark-making devices or another equivalent means.

The safety valve is then held open by the current flowing through the electromagnetic winding on account of the thermoelectric electromotive force generated by the thermocouple.

Retention of the open state is ensured a few seconds after the pilot flame is ignited, as necessary to heat up the thermocouple and its protective case which have low thermal inertia.

In the event of the pilot flame going off, and the thermocouple being cooled the thermocouple current decreases rapidly and is no longer able to oppose the force exerted by a bias spring of the electromagnetic assembly and for closing the safety valve, which is therefore promptly shut off.

The mechanical power for setting and loading the spring is supplied by the operator and to retain the open condition the small power, on the order of few milliwatts, provided by the thermocouple is sufficient, since no work is involved.

Quite different is the situation with the regulator valve, which in order to apply its action should open and close under no intervention by the operator, thereby performing mechanical work.

The regulator valve is generally driven by an electromagnet which is supplied electric power from the mains through a thermostatic switch, and possibly an isolation and voltage stepdown transformer.

The actuator operation is therefore dependent on the availability of an electric power supply network and the presence of a voltage on the network.

To obviate this limitation a flame-safeguarded actuator has therefore been proposed and provided, wherein the thermocouple powering the electromagnetic safety assembly is replaced with a thermopile, that is a plurality of thermocouples in series, capable of supplying an electric power at least one order larger than that from a thermocouple.

The thermopile, additionally to powering the electromagnetic safety assembly, also powers, through a thermostatic switch, the electromagnet driving the regulator valve, obviously using a circuit in parallel with that of the safety assembly.

In this way, the actuator operation is made independent of the availability of an electric power supply network, but another serious drawback is introduced.

A thermopile is of necessity a composite element with several junctions contained within a much larger protective case than that required for a themocouple and on the whole, has much higher (at least one order higher) thermal inertia than a thermocouple, both on heating and cooling.

While this inertia, as relates to the regulating characteristics, may be tolerated, it is unacceptable in the safety valve control, whose operation on the pilot flame going off should be the fastest possible, with a time lag of no more than few seconds.

It has been proposed to obviate this drawback by providing the supply circuit to the safety electromagnet, powered by the thermopile, with a thermostatic switch, e.g. of the mercury vapor type, to detect the presence of the flame and break the circuit in the event of the same being absent.

A mercury vapor thermostat has a thermal inertia and a response time comparable with that of a thermocouple device and the safety time can be brought back to acceptable levels.

However, the use of a mercury thermostat additionally to being expensive, constitutes a potential risk of contamination in the event of breakage of the capillary tube or bulb under stress from the flame and subjected as it is to sharp thermal heads.

These drawbacks are obviated by the multi functional actuator for a flame-safeguarded thermostatically regulated gas burner which forms the subject matter of the present invention and neither requires powering off the mains nor the use of

mercury thermostats, and at the same time has a minimal safety time.

According to the invention, these results are obtained by the combined use of a thermocouple to power the safety assembly and a thermopile to power the driving electromagnet for the regulator valve.

According to a further aspect of the present invention, control of the regulator valve is achieved by means of a servosystem which utilizes the delivery pressure of the fuel gas as a source of energy, to thereby minimize the power requirement on the thermopile for controlling the regulator valve.

The features and advantages of the invention will be apparent from the following description and the accompanying drawings, in which:

Figure 1 shows schematically a cross-section through a multifunctional actuator for flame-safeguarded thermostatically regulated gas burners embodying the present invention;

Figure 2 shows a cross-section through a preferred embodiment of an actuator according to the present invention.

With reference to Figure 1, the actuator of the invention includes a valve body 1 usually comprised of one or more die castings, which forms a gas inlet union 2 communicated to an outlet union 3 through an inner channel 4.

The gas flow from the union 2 to the channel 4 is controlled by a moving shutter 5, which when at rest, through the action of a spring 6, closes a passageway between the union 2 and the channel 4.

The gas flow from the channel 4 to the union 3 is controlled by a moving shutter 7, which when at rest, through the action of a spring 8 closes a passageway between the channel 4 and the union 3.

The shutter 5 is rigid with an axially movable drive rod 9 attached to the moving armature 10 of an electromagnet 11 housed within the body 1 and whose winding circuit is closed by a thermocouple 12.

An axially movable setting rod 13, in axial opposition to the drive rod 9 with respect to the shutter 5, is biased to a home position of non-interference with the shutter 5 by a spring 14.

A tapping conduit 15 open to the inner channel 4 is terminated with a possibly multiple pilot flame feed nozzle 16 facing the thermocouple 12.

By exerting a manual pressure on a setting pushbutton 17 rigid with the rod 13, the latter is brought to interfere with the shutter 5, which will be pushed into an open position with the armature 10 in contact with the poles of the electromagnet 11.

The gas introduced into the union 2 may then flow into the channel 4, and through the conduit 15, feed the nozzle 16 to ignite a pilot flame 18, using known means.

The thermocouple 12, when heated by the pilot flame, generates an electromotive force, and hence a current through the winding of the electromagnet 11 which holds the armature 10 to the closed position and the shutter 5 correspondingly to the open position, even when the setting action applied by the rod 13 is discontinued.

As long as the pilot flame is burning, the magnetic attraction force exerted on the armature 10 oovercomes the force acting on the spring 6 and the shutter 5 is held open.

When for a reason whatever the pilot flame 18 goes off, the thermocouple is cooled rapidly, within few seconds, and the armature 10, being no longer withheld by the magnetic attraction force, is released to close the shutter 5.

The regulating function of the actuator is performed by the shutter 7, which being coupled to the moving core 19 of an electromagnet 20, e.g. of the draw-in type, can be brought to an open or a closed condition, according to whether the electromagnet 20 resists or assists when energized the force applied by the spring 8 which tends to hold the shutter 7 to its closed position.

Thus, to open the shutter 7, a mechanical work must be performed which the power developed by a thermocouple cannot accomplish.

The use is contemplated for this purpose, in combination with the thermocouple 12, of a thermopile 21. which being heated by a second pilot flame 18A (or by the pilot flame 18 itself) will power the winding of the electromagnet 20 through a regulating thermostatic switch 22.

In this way, the actuator of the invention, while retaining the necessary speed of operation of the safety valve formed of the shutter 5, can perform a regulating function, as applied by the shutter 7, with no need for an external power supply, the energy being obtained by thermoelectric conversion from the power of the pilot flame.

Figure 2 shows a preferred embodiment of the actuator according to the invention which combines the aforementioned advantages with other important advantages.

In Figure 2, the body 23 of the actuator accommodates a safety electromagnetic assembly 24 and associated shutter 25 quite similar to the one described and depicted in Figure 1, although the regulating function is obtained in a more elaborate manner.

In fact, the shutter 26, being the equivalent of the shutter 7 in Figure 1, is controlled by a diaphragm actuator linked operatively to an electromagnetic device, rather than by an electromagnet.

The inner channel 28 included between the shutter 25 and the shutter 26 is communicated, as well as to a feed conduit 29 for the pilot flame 30,

to a regulating chamber 31 through a conduit 32, closed at its ends by a consent shutter 33 and a regulating shutter 34.

The consent shutter 33, being biased to the closed position by a spring 35, is held normally open by a cap 36 attached to a setting rod 37 rigid with a setting knob 38.

Upon rotation of the knob 38, provided with a detent dog 39 co-operating with a helical shoulder 40 on the body 23, the stem 37, additionally to being rotated, is pushed to interfere with the shutter 25 causing it to open and the assembly 24 to be set.

With the same operation the cap 36, which normally holds the shutter 33 open, is lowered to allow the shutter 33 to move into a closed position.

In this way, during the pilot flame ignition step and so long as the knob 38 is not moved to a home position, the fuel gas is denied access to the conduit 32.

The regulating shutter 34 is carried on an extension arm 85 of a moving armature 86 of an electromagnet, consisting of a yoke 87 linked to a winding 88.

A spring 89 biases the armature 86 to the open position corresponding with the closed position of the shutter 34.

The winding 88 is energized through a thermostatic switch 41 from a thermopile 50 heated by the pilot flame.

The chamber 31 is communicated by means of a conduit 42 to an actuation chamber 43, closed by an actuating diaphragm 44 which acts on the shutter 26.

The opposite face of the diaphragm 44 is exposed to the outlet conduit 45 of the actuator, which feeds in a known manner, by a nozzle and a diffuser, a plurality of burner ports.

A discharge opening 46 connects the chamber 31 to the chamber 45.

If the pressure within the chamber 31 equals the pressure within the chamber 45, no differential pressure is exerted on the diaphragm 44 and the shutter 26 is held to the closed position by a spring 47 and any delivery pressure of the gas present in the chamber 28 relative to the ambient pressure under which the chambers 31 and 45 find themselves.

On energization of the electromagnet 88, the shutter 34 is opened, and if the shutter 33 is also open, the chamber 31 and chamber 43, being fed combustion gas, reach a pressure very near the gas delivery pressure and ensured by the loss of head which occurs at the discharge opening 46.

The pressure differential which establishes in a gradual fashion across faces of the diaphragm causes the shutter 26 to open gradually and the gas to flow to the burner ports.

Understandably, even with the shutter 26 opened, the shutter should cause a head loss which ensures across the diaphragm 44 the pressure differential required to counteract the thrust from the spring 47 and the thrusts acting on the shutter 26.

In relation to the indeed small dimensions that may be given to the shutter 34, the work required for its operation can be minimized.

It follows that the power required of the regulating electromagnet can be kept within extremely low limits and provided, therefore, by thermopiles.

Upon the winding 88 being de-energized, the shutter 34 will close at once and the pressure within the chambers 31, 43 decrease rapidly as a function of the outflow rate through the discharge opening, so that the shutter 26 will close almost instantaneously.

The foregoing description relates to a general solution scheme of a preferred embodiment.

It may be appreciated, however, that many changes may be made without departing from the spirit of the invention.

For instance, the winding 88 and the yoke 87 may be accommodated fully inside the body 23.

Claims

1. An actuator for flame-safeguarded gas burners with a regulator solenoid valve, comprising a first safety valve (5,25) driven by a first magnetic assembly (10,11,24) with manual setting (17,37,38) and a second regulator valve (7,26) in cascade with said first valve (5,25), a tapping conduit (15,29) intermediate to said first (5,25) and second (7,26) valves for feeding a pilot flame nozzle (16), a pilot flame detecting thermocouple (12) for powering said first magnetic assembly (10,11,24) and holding said first safety valve (5,25) open in the presence of the pilot flame and a thermopile (21,50) for powering an electromagnetic device (20,87,88) driving said second valve (7,26).

2. An actuator as in Claim 1, comprising a mechanical connection between said second valve (7) and said electromagnetic device (20) for driving said second valve (7) directly from said device (20).

3. An actuator as in Claim 1, comprising an air-operated diaphragm actuator (44) linked operatively to said electromagnetic device (87,88) for driving said second valve (26), said electromagnetic device (87,88) controlling a pressure differential applied to said diaphragm (44), said diaphragm separating an actuation chamber (43) from a gas outlet conduit (15).

4. An actuator as in Claim 3, wherein said electromagnetic device (87,88) comprises a moving armature (86) of an electromagnet, provided with an arm (85) for closing and opening a conduit (32) conveying gas from an inner channel (28), included between said first (25) and second (26) valves, into said actuation chamber (43).

5. An actuator as in Claim 4, comprising a manual setting device (37,38,36) for setting said first magnetic assembly (24) and concurrently closing a shutter (33) in said gas conveying conduit (32).

6. An actuator as in Claim 5, wherein said setting device (38) is a pushbutton.

7. An actuator as in Claim 6, wherein said setting device (38) is a rotary knob with axial travel.

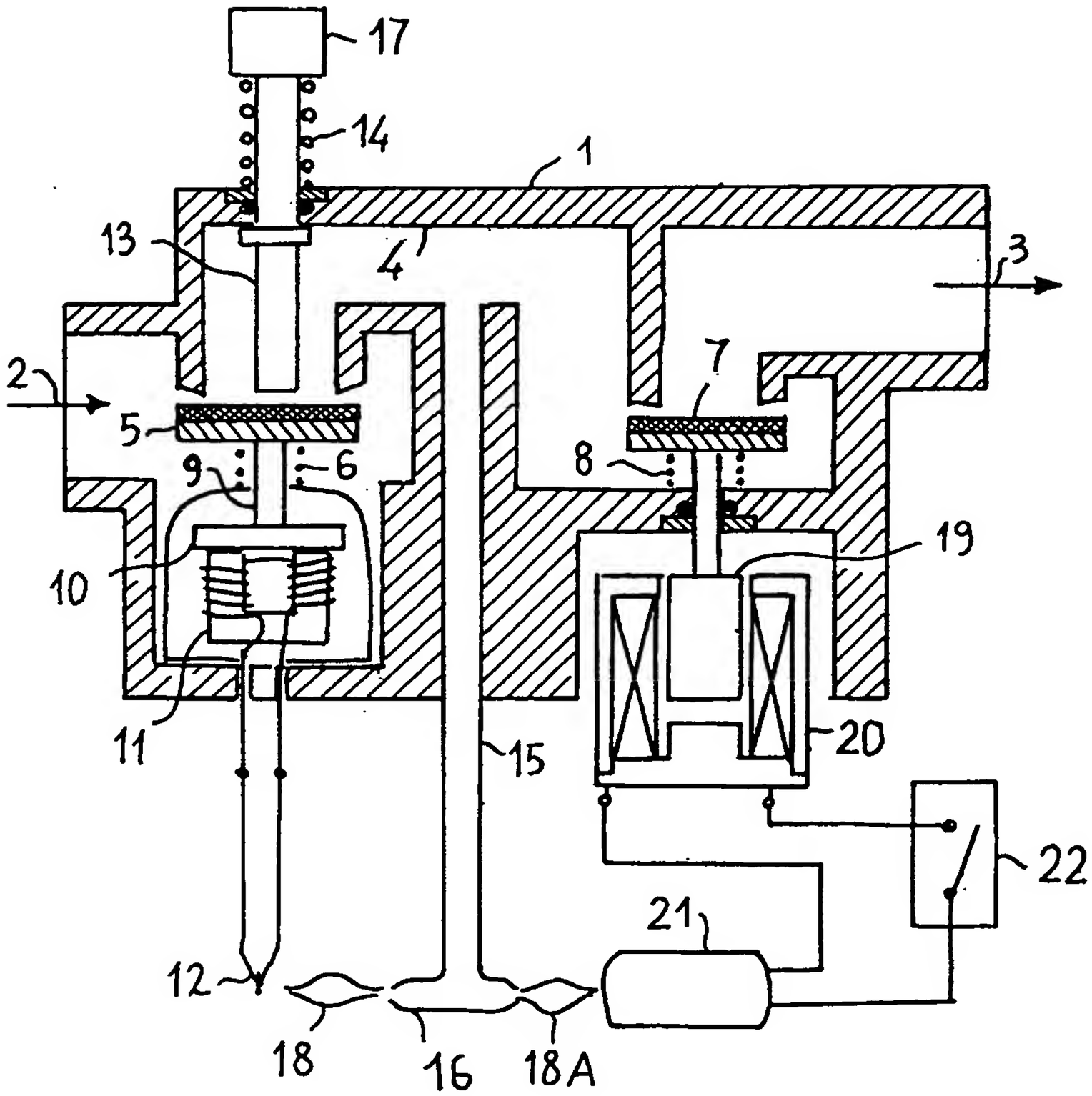
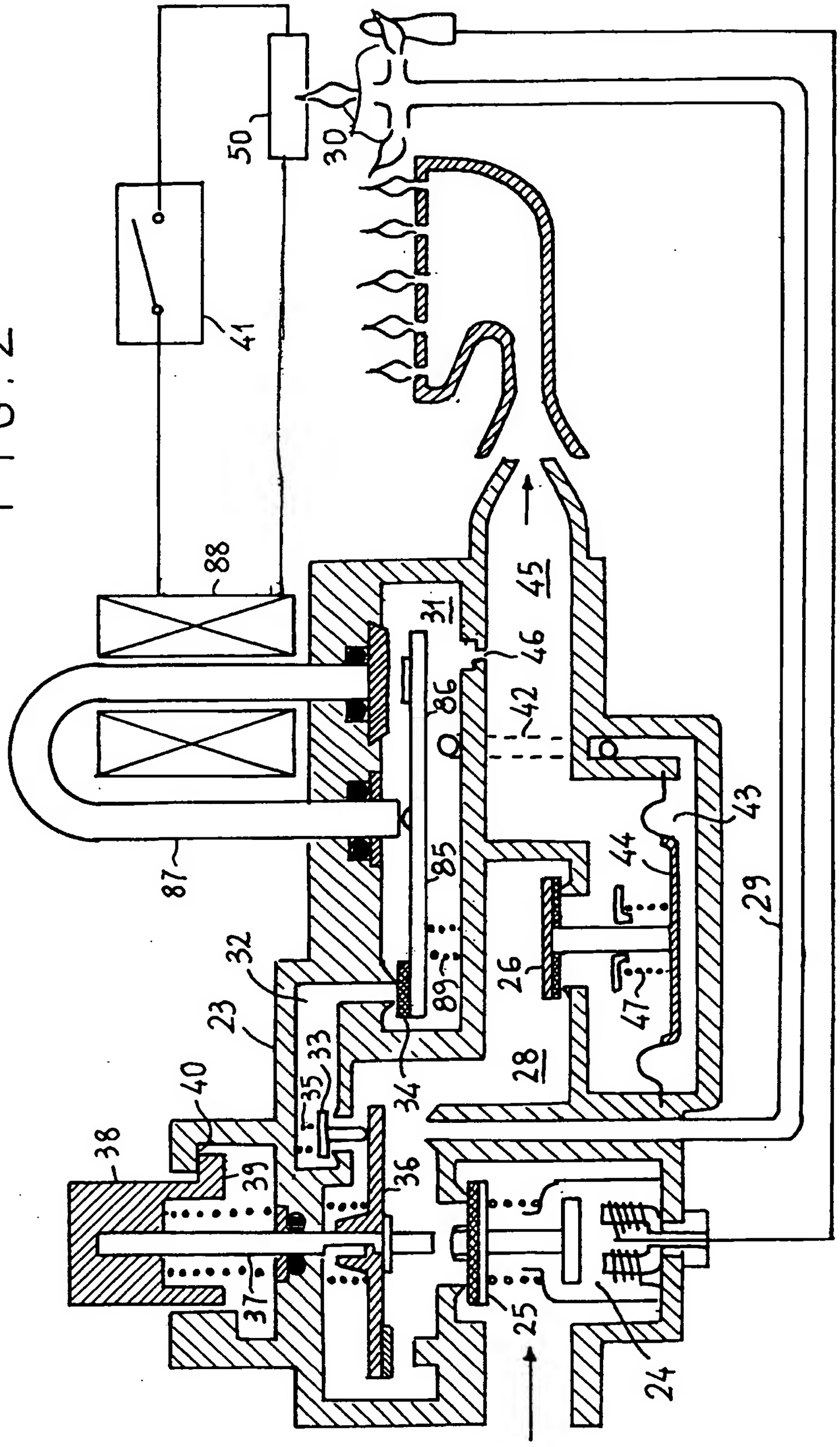


FIG.1

FIG. 2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EUROPEAN SEARCH REPORT

Application Number
EP 94 20 1400

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.6)
X A	US-A-3 151 660 (EVRAETS) * the whole document * ---	1,3,4 5,6	F23N5/10
X A	US-A-2 999 536 (SCHWALLBACH) * the whole document * ---	1,2 6,7	
X	US-A-2 384 696 (RAY) * the whole document * ---	1,2	
A	FR-A-1 232 440 (THEOBALD) * figures * ---	5	
X	DE-B-11 58 016 (BASO) * the whole document * ---	1,3	
A	EP-A-0 433 528 (PAUL ISPHORDING METALLWERKE) * the whole document * -----	7	

TECHNICAL FIELDS SEARCHED (Int.Cl.6)

F23N

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	7 October 1994	Kooijman, F

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
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EPO FORM 1503 03.82 (P04C01)

DERWENT-ACC-NO: 1995-053765

DERWENT-WEEK: 199717

TITLE: Actuator for flame-protected **gas burner** having solenoid **control valve - has safety valve driven by magnetic assembly having manual setting, control** valve, tapping conduit between valves for feeding pilot flame nozzle, and pilot flame thermocouple sensor

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PATENT-ASSIGNEE: SIT LA PRECISA SRL[SITPN]

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PATENT-FAMILY:

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IT 1264955 B	October 17, 1996	N/A	000	F23D 000/00

DESIGNATED-STATES: DE FR GB

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APPLICATION-DATA:

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EP 635680A1	N/A	1994EP-0201400	May 18, 1994
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INT-CL (IPC): F23D000/00, F23N005/10

ABSTRACTED-PUB-NO: EP 635680A

BASIC-ABSTRACT:

The actuator for a **gas burner** has a first safety valve (5) driven by a magnetic assembly (10,11) having a manual setting (7). A second control valve (7) is cascaded with the first valve, and a tapping conduit 915) is located between the two valves.

The conduit feeds a pilot flame nozzle (16), and a pilot flame detecting thermocouple (12) activates the magnetic assembly, and holds the first valve open in the presence of a pilot flame. A thermopile (21) drives a solenoid coil directly via a mechanical connection to operate the second valve. The actuator includes an air-operated diaphragm actuator which is linked to the solenoid drive device.

USE/ADVANTAGE - E.g. for household gas-burning appliance e.g. oven, boiler, heater having strict safety standards. Does not require power-off of mains, or use of mercury thermostats, while having minimal safety time using servo-system

control. Minimised power of thermopile for controlling valve.

CHOSEN-DRAWING: Dwg.1/2

TITLE-TERMS: ACTUATE FLAME PROTECT **GAS BURNER** SOLENOID **CONTROL VALVE SAFETY VALVE DRIVE MAGNETIC ASSEMBLE MANUAL SET CONTROL** VALVE TAP CONDUIT VALVE FEED PILOT FLAME NOZZLE PILOT FLAME THERMOCOUPLE SENSE

ADDL-INDEXING-TERMS:
DOMESTIC HEATER OVEN BOILER AIR-OPERATED

DERWENT-CLASS: Q73 X27

EPI-CODES: X27-G02;

SECONDARY-ACC-NO:
Non-CPI Secondary Accession Numbers: N1995-042232